Appendix 15A
ISOLATION DESIGN PARAMETERS

15A.1 SLIDING ISOLATION SYSTEMS

The λ factors on sliding systems are applied to Q_d.

15A.1.1 Factors for Establishing λ_{min}

$\lambda_{min} = 1.0$

15A.1.2 Factors for Establishing λ_{max}

	Unlubricated PTFE		Lubricated PTFE		Bimetallic Interfaces	
Condition / Environment	Sealed	Unsealed	Sealed	Unsealed	Sealed	Unsealed
Normal	1.1	1.2	1.3	1.4	2.0	2.2
Severe	1.2	1.5	1.4	1.8	2.2	2.5

15A.1.2.1 $\lambda_{max,a}$

Notes:

- Values are for 30-year exposure of stainless steel. For chrome-plated carbon steel, multiply values by 3.0.
- Unsealed conditions assumed to allow exposure to water and salt, thus promoting further corrosion.
- Severe environments include marine and industrial environments.
- Values for bimetallic interfaces apply for stainless steel and bronze interfaces.

15A.1.2.2 $\lambda_{max,v}$

Established by test.

C15A.1 SLIDING ISOLATION SYSTEMS

Woven PTFE shall be treated as unlubricated PTFE.

C15A.1.2.1 $\lambda_{max,a}$

The aging factor is based on friction data for rough stainless steel plates with PTFE or other materials. It is assumed that the plate has uniform corrosion, which creates a rougher sliding surface.

For bimetallic interfaces, the factor is based on data for stainless steel and leaded bronze interfaces (Lee 1993). Increases in friction due to stress effects have been observed in the absence of corrosion.

15A. 1.2.3 $\lambda_{max,c}$

	Unlubricated PTFE	Lubricated PTFE	Bimetallic Interfaces
Sealed with stainless steel surface facing down	1.0	1.0	1.0
Sealed with stainless steel surface facing up*	1.1	1.1	1.1
Unsealed with stainless steel surface facing down	1.1	3.0	1.1
Unsealed with stainless steel surface facing up	Not Allowed	Not Allowed	Not Allowed

* Use factor of 1.0 if bearing is galvanized or painted for 30-year lifetime.

15A. 1.2.4 $\lambda_{max,tr}$

Cumulative Travel		**Unlubricated PTFE***	**Lubricated PTFE**	**Bimetallic. Interfaces**
ft	m			
<3300	1005	1.0	1.0	To be established by test
<6600	2010	1.2	1.1	To be established by test
>6600	2010	To be established by test	To be established by test	To be established by test

* Test data based on 1/8-inch sheet, recessed by 1/16 inch and bonded

15A. 1.2.5 $\lambda_{max,t}$

Minimum Temp for Design		**Unlubricated PTFE**	**Lubricated PTFE**	**Bimetallic Interfaces**
F°	C°			
70	21	1.0	1.0	To be established by test
32	0	1.1	1.3	
14	-10	1.2	1.5	
-22	-30	1.5	3.0	

C15A.1.2.3 $\lambda_{max,c}$

Values shown in the table assume that the sliding interface will not be separated.

Sealed bearings shall have a protective barrier to prevent contamination of the sliding interface. The protective barrier shall remain effective at all service load displacements.

15A.2 ELASTOMERIC BEARINGS

The λ factors on elastomeric systems are applied to K_d and Q_d.

15A.2.1 Factors for Establishing λ_{min}

λ_{min} = 1.0

15A.2.2 Factors for Establishing λ_{max}

C15A.2 ELASTOMERIC BEARINGS

Elastomeric bearings are produced in a variety of compounds (particularly high-damping rubber bearings), so that a vast number of experiments are needed to establish the relevant λ factors.

Moreover, available data on the behavior of rubber bearings are limited to a small range of parameters, usually established for a particular application. Even in the case of lead-rubber bearings (which found wide application in bridges), data on the effect of temperature are scarce and include one bearing tested in New Zealand at temperatures of –31, 5, 64, and 113° F (–35, –15, 18, and 45°C); one tested in the United States (Kim et al. 1996) at temperatures of – 18 and 68°F (–28 and 20°C); and one in Japan tested at –4 and 68°F (–20 and 20°C).

The factors listed herein are based on the available limited data. In some cases the factors could not be established and need to be determined by test.

It is assumed that elastomeric bearings are tested when unscragged at temperature of 70ºF ±10ºF (21°C ±5°C) to establish the relevant properties. Testing is performed at the design displacement and a frequency less than the inverse of period T_{eff}. The first cycle loop is used to establish the maximum value of effective stiffness (k_{max}) and area under loop (A_{max}). The minimum values (as a result of scragging) are established as the average of three cycles to be k_{min} and A_{min}.

It is also assumed here that scragging is a reversible phenomenon – that is, rubber recovers after some time its initial, unscragged properties. High-damping rubber bearings may exhibit significant difference between unscragged and scragged properties, although this difference depends entirely on the rubber compound.

15A.2.2.1 $\lambda_{max,a}$

The aging factor depends significantly on the rubber compound. As a general rule, it is expected that this factor is close to unity for low-damping natural rubber and to be more for high-damping rubber.

C15A.2.2.1 $\lambda_{max,a}$

The relationship between aging and scragging was assumed in the table. However, such a relationship has not been verified by testing.

	Kd	Qd
Low-Damping natural rubber	1.1	1.1
High-Damping rubber with small difference between scragged and unscragge properties	1.2	1.2
High-Damping rubber with large difference between scragged and unscragge propertie	1.3	1.3
Lead	-	1.0
Neoprene	3.0	3.0

Notes:

- A large difference is one in which the unscragged properties are at least 25 percent more than the scragged ones.

15A.2.2.2 $\lambda_{max,v}$

Established by test.

15A.2.2.3 $\lambda_{max,c}$

$$\lambda_{max,c} = 1$$

15A.2.2.4 $\lambda_{max,tr}$

Established by test.

15A. 2.2.5 $\lambda_{max, t}$

Minimum Temp for Design		Qd			Kd		
F°	C°	HDRB[1]	HDRB[2]	LDRB[2]	HDRB[1]	HDRB[2]	LDRB[2]
7 0	21	1.0	1.0	1.0	1.0	1.0	1.0
3 2	0	1.3	1.3	1.2	1.2	1.1	1.1
1 4	-10	1.4	1.4	1.4	1.4	1.2	1.1
22 -	-30	2.5	1.5	1.5	2.0	1.4	1.3

HDRB = High-Damping Rubber Bearing
LDRB = Low-Damping Rubber Bearing

1. Large difference (at least 25%) between scragged and unscragged properties.
2. Small difference (< 25%) between scragged and unscragged properties.

15A. 2.2.5 $\lambda_{max,scrag}$

Qd			Kd		
LDRB	HDRB with β_{eff} -0.15	HDRB with β_{eff} >0.15	LDRB with	HDRB with β_{eff} -0.15	HDRB with β_{eff} >0.15
1.0	1.2	1.5	1.0	1.2	1.8

C15A.2.2.5

Values for lead-rubber bearings are based on grade 3 natural rubber.